Simple Nuclear Reactions

Nuclear Reactions

- involve changes in the make up of the nucleus
- change in # of protons and neutrons within the atom

Simple Nuclear Reactions

1. Nuclear Decay
    a. Alpha Decay
    b. Beta Decay
    c. Gamma radiation
2. Nuclear Fission
3. Nuclear Fusion

Tips for balancing Nuclear Reactions

1. The sum of the mass numbers (superscripts) must be the same on both sides of the equation
2. The sum of the atomic numbers (subscripts) must be the same on both sides of the equation
3. Refer to the atomic number to determine the type of element

Important Symbols

Alpha particle: $^{4}_{2}He$

= **Helium nucleus** = 2 protons, 2 neutrons, no electrons
= charge of +2 (since no electrons)

Beta particle: $^{0}_{-1}e$

= **electron**
= charge of -1

Gamma radiation: $^{0}_{0}\gamma$

= high energy radiation
= no mass
= no charge

Neutron = $^{1}_{0}n$

= mass of 1
= no charge

1. **Nuclear Decay**

- Doesn't depend on the chemical environment the atom is in
- Reaction cannot be stopped
- All elements heavier than bismuth can "decay" into lighter elements and some lighter elements can also decay

a) **Alpha Decay (aka alpha particle emission)**

- involves the loss of 1 alpha particle, $^{4}_{2}He$

eg: $^{226}_{88}Ra \longrightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

Problems:

1: $^{238}_{92}U \longrightarrow \_\_\_\_\_ + {}^{4}_{2}He$

2. $\_\_\_\_\_ \longrightarrow {}^{248}_{97}Bk + {}^{4}_{2}He$

b) **Beta Decay**

- involves the loss of 1 beta particle, $^{0}_{-1}e$

eg: $^{3}_{1}H \longrightarrow {}^{3}_{2}He + {}^{0}_{-1}e$

Problems:

1: $^{73}_{31}Ga \longrightarrow \_\_\_\_\_ + {}^{0}_{-1}e$

2. $\_\_\_\_\_ \longrightarrow {}^{90}_{39}Ti + {}^{0}_{-1}e$

c) **Gamma Radiation**

- involves the loss of gamma radiation, $^{0}_{0}\gamma$
- often accompanies alpha or beta particle emission
- gamma ray is emitted when an unstable product of an alpha or beta decay stabilizes itself

eg $^{137}_{55}Cs \longrightarrow {}^{137}_{56}Ba + {}^{0}_{-1}e + {}^{0}_{0}\gamma$

Problem: $^{238}_{92}U \longrightarrow {}^{234}_{90}Th + \_\_\_\_\_ + 2\ {}^{0}_{0}\gamma$

2. Nuclear Fission:

- involves a larger atom being broken down into 2 or more smaller atoms, and releasing a large amount of energy
- usually involves the “firing" of a neutron at the nucleus of the large atom – the neutron "bullet" causes the atom to split into smaller atoms (neutron particles will also be released)

eg $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{92}_{38}Sr + {}^{142}_{54}Xe + 2\ {}^{1}_{0}n +$ Energy (gamma rays)

(this reaction occurs in the CANDU nuclear reactor)

Problem:

$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{87}_{35}Br + \_\_\_\_\_ + 3\ {}^{1}_{0}n +$ Energy (gamma rays)

3. Nuclear Fusion:

- involves 2 or more atoms fusing together to form one larger atom, neutron particle(s) and releasing a large amount of energy
- aka **thermonuclear reactions** due to the large amounts of energy released
- the end products of fusion are usually light, stable nuclei rather than heavy radioactive ones produced in fission reactions.
- Problem with nuclear fusion is that to combine nuclei, the mutual repulsion (between the protons) must be overcome and a lot of energy must be initially added before the reaction can take place

eg $^{3}_{1}H + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n +$ Energy (gamma rays)

(this reaction occurs in our Sun and in any other stars)

Problem:

$^{235}_{92}U + {}^{12}_{6}C \longrightarrow {}^{246}_{98}Cf + {}^{1}_{0}n +$ Energy (gamma rays)

Homework:

Read pages 142-147 of textbook
Work on #29-39 on pages 142-147
Work on #1-5 on page 147-148
Work on #13 on page 150
Check out the animations on the following site:
http://www.visionlearning.com/library/module_viewer.php?c3=&mid=59&l